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Environmental Effects of Dredging Technical Notes

SUMMARY OF VALUATION METHODS FOR WETLANDS

PURPOSE: This Technical Note summarizes a review of economic valuation methods for wetlands. The summaries provided herein explain the valuation methods or process and illustrate the data requirements for valuation of wetlands.

BACKGROUND: Wetlands provide many benefits, including fish and wildlife habitat, recreation, flood control, and water quality improvement. These services provided by a wetland have economic value if there is private or public demand for the products, goods, or services. Wetlands have been valued for a variety of wetland services including such things as flood control or water supply benefits, or the value of a wetland for shellfish production or for wetland recreation. A review of wetland valuation studies was undertaken to identify valuation methods that could be used for Corps Planning or Operations activities. This Technical Note summarizes the existing methods for valuation of wetland services, based on a literature review (Shabman and Batie in preparation) and an updated literature search.* The existing valuation methods form the basis for developing guidance for valuation of wetlands to support the Wetland Evaluation Technique (WET) (Adamus et al. 1987), or other wetland assessment effort.

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Introduction

Evaluation of wetlands and wetland alteration projects has focused on the ecological and biological functions of wetland systems. Consideration of economic values in wetland projects has been limited due to lack of understanding of how and when to include economic considerations. A framework for determining

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wetland economic values was developed by Shabman and Batie (in preparation), and summarized in Technical Note EEDP-06-7.

A literature review of wetland valuation studies revealed that few efforts have been made to determine the total economic value of a wetland. Rather, the value of specific goods or services, e.g., recreation, has been the focus. This Technical Note presents the summaries of wetland valuation studies, organized by the services that are valued. Technical Note EEDP-06-7 related these services to the wetland functions and values assessed in WET.

Water Quality

Wetlands improve water quality through sediment/toxicant retention and nutrient removal/transformation. These functions provide cleaner water for downstream areas, and in some areas, wastewater treatment. For the economic benefits of downstream water quality, data are currently being collected to quantify sediment and nutrient transformation activity in bottomland hardwoods in the southeast; little other quantitative data exists. For wastewater treatment, it is possible to calculate costs of treatment by alternative methods.

Valuation of wetland water quality benefits requires identifying the costs of substitutes for the water quality services. The value of the water quality service could be determined by the costs of chemical or other treatment to provide the same level of water quality. For sediment retention, the costs of retention dams or other structures could be used to value the sediment retention services. More quantitative data on wetland sediment and nutrient functions will allow these types of valuations.

The value of a wetland for wastewater treatment is the difference between the costs of using the wetland for treatment and the costs of using the least-cost alternative (Shabman and Batie in preparation). Use of wetlands for wastewater treatment is regulated by states to ensure that the type, nature, and functions of the wetland area are protected (Florida Administrative Code 17-6). The costs for wastewater treatment thus include the long-term monitoring program to ensure compliance with water quality and fish and wildlife standards during operational phases (Schwartz n.d.).

Flood Control

Wetlands store flood waters from upstream runoff. Alterations of a wetland will cause a change in flood-control capacity due to diminished flood storage capacity. Similarly, coastal wetlands provide protection from storm surges. For water resources project evaluation, the annualized value of damages prevented is used to evaluate projects (US Water Resources Council 1983). Thus, the valuation of flood-control services requires determining the flood-control or surge protection capacity of the wetland and determining a value for the flood losses if the capacity is lost. An understanding of the wetland hydrologic budget, i.e., retention capacity, is required to estimate flood damages. For coastal wetlands, valuation requires determining the value of losses that would occur without the storm surges.

A 1971 study of the Charles River Basin in Massachusetts established a value of expected annual damages of $647,000 based on a 30-percent reduction in natural wetland storage, using existing trends in wetland loss (Shabman and Batie in preparation). The value was revised upward in 1976 to $2,022,000. Calculation of total flood-control value involves summing damages caused by floods of different probabilities. The expected annual damages is calculated as the total flood-control value divided by the number of years of project life. These values must be compared to the least-cost alternative.

Several Districts have valued wetland storm surge protection as a part of coastal marsh loss projects. These studies are currently undergoing review.

Water Supply

The groundwater recharge and discharge functions of wetlands provide a potential source of water supply. For valuation, there must be an understanding of the capacity for sustainable yield by the aquifer for water supply. Wetlands have not been extensively used for water supply as evidenced in the literature, likely due to the uncertain relationship between wetlands and aquifer capacity.

The value of a wetland water supply is the lesser of (1) the value of the wetland water supply services to the consumer (if no alternative supply exists), or (2) the difference in costs between the development of the wetland supply and the development costs of an alternative source. To determine the

difference in costs between the wetland and an alternative entails determining the costs of providing the water supply from other sources, and then comparing these costs to the wetland source. Gupta and Foster (1975) valued a wetland water supply in Massachusetts (in 1972 dollars). A difference of 7.13 cents per 1,000 gallons was attributed to the wetland water supply.

Recreation

The measure of value for consumptive outdoor recreation used by Federal agencies is the willingness-to-pay (WTP) for recreation. WTP for recreation is the sum of two components: any entrance fee and user costs including all associated travel costs plus any excess amount the recreationist is willing to pay above the user fee and charges. This amount that the recreationist is willing to pay but does not have to pay is the consumer's surplus (Vincent, Moser, and Hansen 1986). There are three accepted methods for determining WTP: (1) Travel Cost Method, (2) Contingent Valuation Method, and (3) Unit Day Values (US Water Resources Council 1983). Use of one method over another is determined by the attributes of the wetland and its recreation use.

Travel Cost Method

The Travel Cost Method uses the costs of travel and the value of travel time as a proxy for WTP. This method assumes that recreationists react to increases in travel expenditures as they do to increases in admission fees. Distance or travel time acts as a barrier for different users. The method is limited because trips with multi-destinations cannot be measured, it does not measure consumer surplus directly, and it cannot evaluate specific components of a wetland recreation experience, such as fishing (Vincent, Moser, and Hansen 1986).

Costanza and Farber (1985) used a Travel Cost analysis to estimate WTP for wetland recreation in Terrebonne Parish, Louisiana. Four distinct rings of travel distances for recreationists to the parish were established, with an estimated annual WTP of $2,153,000 (1985 dollars).

Contingent Valuation Method

The Contingent Valuation Method establishes WTP by developing a hypothetical market for recreation. In this hypothetical market, recreationists respond to changes in price and availability of resources. Contingent valuation assumes the consumer can assign an accurate WTP value to their recreation experience and this valuation can be directly elicited in response to questionnaires. A

respondent is asked if they would be willing to pay a stated amount for recreation. Several alternative bidding procedures may be used to estimate maximum WTP. Titre et al. (1988) used a Contingent Valuation analysis for valuing wetland recreation in seven parishes in south Louisiana. This study estimated a WTP value of between $327 and $360 per recreation user per year.

There are several limitations to the use of this method. Because the method is a stated preference approach, there is the potential for the responses to be biased. There is also concern whether individuals actually know their true WTP (Vincent, Moser, and Hansen 1986).

Unit Day Method

The Unit Day Method for estimating WTP relies on expert judgments to approximate average dollar values (US Water Resources Council 1983). Specific criteria for the recreation site and use of the site are associated with ranges of dollar values for WTP. The primary concern with Unit Day values is that the method inherently relies on professional judgment and may not adequately reflect site-specific differences or user preferences.

Habitat

Wetland habitat can be valued as (1) the existence, conservation, or preservation value of the wetland ecosystem; (2) value of commercial fish and wildlife; and (3) nonconsumptive recreation uses, such as sightseeing or bird watching, which are dependent on wetland habitat. The approaches to habitat valuation have been (1) costs to replace wetland habitat and (2) WTP for consumptive and nonconsumptive uses.

The value to society of preserving wetland habitat as an important ecosystem, or for preservation or bequest value (i.e., preserving the wetland for future generations) can be determined through a Contingent Valuation study, as described in "Recreation" above. No studies to date have attempted to determine the existence or conservation value for wetlands. Preservation values have been developed, however, for preservation of wilderness areas, using the Contingent Valuation Method (Walsh, Loomis, and Gillman 1984).

Valuation of wetland habitat for particular species requires establishing the productivity of habitat for those species. In a study of Michigan wetlands, Tilton, Kadlec, and Schwegler (1978) estimated the value of wetlands for pike production. The analysis assumed that an acre of wetland can produce 1,800 pike

per year. The value of the natural habitat was evaluated as the cost of purchasing a wetland and upgrading it to produce 1,800 pike a year, or constructing a wetland. This approach was also used to value replacement of a waterfowl area. The study did not document the basis for the productivity figure, and did not include the value of other services, e.g., wildlife habitat, that may also be provided by the wetland.

The ability to link WTP for sport fishing or hunting with potential productivity of wetlands requires linking of WTP information, as described in "Recreation," with habitat assessment models for particular species. The Human Use and Economic Evaluation (HUEE) portion of the Fish and Wildlife Habitat Evaluation Procedures (HEP) provides such a method (US Fish and Wildlife Service 1985). HUEE requires a substantial amount of information to use HEP results to produce economic values. The Habitat Units (HU), the units produced by HEP, must be converted to the number of User Days the HUs could support. There may be little factual or technical basis on which to make this conversion. The value for WTP for a User Day is determined through a Travel Cost or Contingent Valuation Method (see "Recreation"). The User Day values are multiplied by the number of Sustained Use Days to determine total value. There has been limited application of the HUEE analysis, likely due to the extensive data requirements.

The value of habitat for nonconsumptive recreation uses, such as sightseeing and birdwatching, may be determined through Unit Day Values, Travel Cost Method, or through Contingent Valuation Methods (see "Recreation").

Commercial Harvest of Fish and Game

For wetland species that are harvested commercially, there is information on market price, costs of production, and some information on productivity of wetland areas. This information can be used to determine a value per acre for fish and game production. The linkage between wetland habitat and the production of fish and game is difficult to establish because there are so many variable production factors. The relationship of acreage of habitat and other factors of production, to the amount (pounds) of catch or harvest is known as the production function. Because of the complexity of fish and game production, some valuation methods assume a direct relationship between habitat and productivity, i.e., that all acres are of equal productivity. This is likely not the case.

Commercial fishery production

Valuation of wetlands for production of fish, shrimp, oysters, and other species requires developing a relationship between the catch of fish and the habitat, labor, and other production factors required to catch the fish. Of the valuation methods examined, the Marginal Value Product (MVP) method considers more of the production factors associated with the fishery than the other methods, which will only be summarized. However, the method is highly data intensive.

MVP method. The MVP method provides an average value for an acre of wetland habitat by determining the change in total revenue associated with a change in acreage. Marginal products are the change of catch as related to a change in production factors, e.g., habitat (Lynne, Conroy, and Prochaska 1981). The marginal products are normally expressed as change in catch as related to either change in harvest effort, e.g., man-days or numbers of traps, or to a change in habitat acreage. Marginal products expressed as change in habitat acres are of greatest interest. The MVP values, that is, the dollar value per acre, are calculated by multiplying the marginal product by the price per pound of the fish or shellfish.

The MVP method has been used to value oyster production in Virginia (Batie and Wilson 1978) and blue crab production in Florida (Lynne, Conroy, and Prochaska 1981). These studies developed values per acre for production of the species through development of a regression equation for the production function. Data used in the regression analyses covered a large coastal area.

For oyster production, the production function used level of effort, number of acres available for oyster harvest, actual number of acres leased for harvest, and salinity (Batie and Wilson 1978). For each of the coastal counties in Virginia, a marginal product was calculated by using the production function, and using the salinity and other variables for that particular county. The marginal product for each county was multiplied by the dockside price per pound of oysters to give the MVP for each county. For the 17 counties considered, the MVP ranged from $1.13 to $141.46 per acre. The range in MVP for the counties is accounted for by variations in the quantity of wetland, amount of effort required, salinity of the waters, and other variables in the production regression equation.

In the study of blue crab fishery on the Florida Gulf Coast, the catch changed in relation to the number of acres and to the level of effort, i.e., the

number of traps (Lynne, Conroy, and Prochaska 1981). For the mean level of effort of 33,000 traps for the entire coast, the yield was 2.3 lb of blue crab per acre. Using the dockside value of $0.25 to $0.30 per pound, the total present value of a wetland acre was estimated at $3.00 for blue crab production.

Other methods for fishery valuation. Several other methods have been used or suggested for valuation of commercial fishery habitat, each with its own limitations. The expenditure method imputes the value of wetland habitat to be the expenditures for the fish harvested (Waters 1986). The value of the wetland for commercial fishery habitat is then the expenditures for harvesting and processing the product; the method ignores the amount the consumer would have been willing to pay above the market price (consumer's surplus) (Waters 1986). The residual return method places the value of the habitat as that value that remains, i.e., the residual value, after all other factors of production are subtracted (Batie and Shabman 1982). The residual return method requires a more quantitative understanding of the fishery production function and supply and demand for the fish than is usually possible.

Commercial game habitat

Less work has been done on valuation of commercial production of furbearers in wetlands. Existing work has used the average productivity of wetlands and existing pelt and carcass prices to value the wetland for furbearer production. The value of muskrats and raccoons for the coastal wetlands of Michigan was calculated by Jaworski and Raphael (1978). This was accomplished by considering the productivity of the wetland for the species (animals per acre), availability of requisite habitat in the wetland, and the market value of the carcass or pelt. Work by the Michigan Department of Natural Resources and other sources provided estimates of the productivity or densities of animals for each of the wetland types. From wetland mapping, the number of habitat acres for each county was determined. Carcass and pelt values reported from the previous year were used to calculate the total value for the furbearers.

Residential Land Development

Development of wetland areas for residential or commercial lots is often highly desirable because of the locational, e.g., on the water, and scenic amenities of such lots. Development and sale of wetland lots for residential use occurs within a functioning land market that affects the value of the

residential lot. Valuation of wetland lots has been accomplished through two valuation approaches: (1) Hedonic Price Approach and (2) Land Market Analysis.

Hedonic Price Approach

The Hedonic Price Approach uses regression analysis to determine the value of wetland development based on characteristics of the wetland. A regression model is developed that relates the price of the lot to the wetland characteristics of the site, based on land transfer records of similar sites. Proposed developments are valued by identifying case study areas of a similar developed wetland area, developing a regression model for the case study area and then using the lot characteristics of the proposed development in the model to determine the value of the proposed development (Shabman and Bartelson 1979, Abdalla and Libby 1981).

A study by Batie and Mabbs-Zeno (1985) developed a model for the price of wetland sites in a large development in Virginia. The regression equation expressed land price as a function of waterfront or canal location, size of lot, and other amenities. Examination of the regression results showed a number of things. The market value of lots is dependent on where they are located, e.g., canal or open water, lot size, and the amenities that are available, e.g., sewer. Consumers were willing to pay $0.157 for each square foot of lot, $882 for access to a sewer, and would pay $4,108 for a lot on a canal but $7,410 for a lot on open water. Lots located adjacent to a wetland are valued at $1,120 less than lots not adjacent to wetlands. As with any regression analysis, some interpretation is required. It is uncertain whether the $1,120 lower value means that wetland location is a disamenity or that the lower value reflects reduced development costs over a fastland development, or perhaps there is some other explanation. This regression analysis could have been used as a case study for valuation of potential developments in the area, though this was not the intent of the study.

Land Market Analysis

Land Market Analysis determines the value of the development based on the change in land rents from the development. (Land rents are the revenues generated from the developed property minus labor and other costs of development (Randall 1987)). That is, the wetland development is viewed as a part of the supply of future developed lands in the market. Luken (1976) used Land Market Analysis to determine development values for San Francisco Bay wetlands.

Using a regional analysis, it was estimated that 4 square miles of wetlands

would be required for development because there were no fastland, nonwetland alternatives. Luken used changes in aggregate land rents across all land parcels, e.g., commercial or residential, in the region to represent the value of development to 1990 (the end point in Luken's analysis). Land rent values in the region with and without the different levels of wetland development were compared.

Agricultural Development

The incentive to drain wetlands to plant agricultural crops has resulted in much of the loss of wetlands in rural areas (Leitch and Grosz 1988). Until recently, there were no economic incentives for wetland preservation on farms. In 1985, Congress passed the Food Security Act of 1985 including its Swampbuster Provisions. The Act established government target prices for crops and the Swampbuster Provisions made farmers ineligible for government target prices if crops are grown on converted wetlands (Baltezore, Leitch, and Nelson 1987).

The economic value of wetlands for agricultural development is the change in the farmer's economic surplus, i.e., return to the farmer, that results from wetland conversion. Determining a farmer's economic return from wetland conversion can become complicated. Because the farmer will try to maximize net revenues from farming, the decision on whether to drain wetlands must account for the Swampbuster Provisions, the profitability of different crops given the market for the respective crops and government target prices, and the availability of suitable lands to be rented, as substitutes for wetland conversion.

A straightforward way to determine a farmer's economic surplus is suggested by Shabman and Batie (in preparation). Basically they argue that farm budgets can be used to calculate a farmer's net income, i.e., economic surplus, with and without wetland conversion. Prices received for output times production on the developed wetland would be used to calculate gross income. Costs of production on the wetland, including development costs and farm production costs, would be subtracted from gross income to calculate returns to the farmer. The prices and costs used for these calculations must be adjusted for effects from government policies such as the Swampbuster Provisions, agricultural price supports, and other market conditions. The gain in net income from conversion would measure the benefits for farmers of wetland development and, in turn, the cost to farmers of preventing them from converting wetlands.

Baltezore, Leitch, and Nelson (1987) evaluated the profitability of draining for farm lands in North Dakota using linear programming to optimize net return to the farmer. The conclusion for the drain/no drain decisions is that each wetland drainage decision must be made on an individual basis. Regional and county crop productivities and prices, and variations in drainage costs make a site-specific analysis necessary.

The optimization for the North Dakota study used three price options: (1) government target prices provided under the Swampbuster Provisions, (2) historic county average prices based on the preceding five years' local grain elevator prices, and (3) current year forward contract prices, the contract prices between the farmer and grain elevator for delivery of grain in August. Short- and long-term payment of the drainage costs were also considered. The crop production mix of wheat/barley was adjusted to maximize returns. In considering the 55-acre fields, the net revenues generated under the options showed the highest return for long-run government price option ($5,417), next was the long-run historic average ($4,787), followed by the no drainage government target ($4,290) (1986 dollars).

Summary

The economic value of various wetland services can be determined, as indicated by the discussion of the valuation studies. Use of these valuation methods is limited by the data and other resources required for use of the methods and by the limited quantitative understanding of wetland processes. As wetland functions are better modelled and quantified, then economic valuation will become easier.

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